

APPARATUS HAVING A HOUSING AND HAVING AT LEAST ONE ROTATING
COMPONENT DISPOSED IN THE HOUSING

[0001] Background of the Invention

[0002] The invention is based on an apparatus having a housing and having at least one rotating component, disposed in the housing, as generically defined by the preamble to claim 1.

[0003] One such apparatus is known from German Patent Disclosure DE 196 25 564 A1. This apparatus is a gear feed pump for a fuel injection system of an internal combustion engine, and it has a housing in which a pair of gear wheels, driven to rotate, is disposed. The gear wheels are supported radially and axially in the housing. The housing is of lightweight metal, such as aluminum. The housing has journals, on which the gear wheels are radially supported, and walls, which form axial bearings for the gear wheels. Because of the low hardness of the lightweight metal comprising the housing, severe wear occurs during operation of the gear feed pump, so that the pump attains only a short service life.

[0004] Advantages of the Invention

[0005] The apparatus of the invention having the characteristics of claim 1 has the advantage over the prior art that by means of the coating comprising a nickel alloy, less wear to the bearing of the at least one rotating component and thus a longer service life of the apparatus are achieved.

[0006] In the dependent claims, advantageous features and refinements of the apparatus of the invention are disclosed. Wear to the bearing is reduced further by the embodiment defined by claim 3.

[0007] Drawing

[0008] One exemplary embodiment of the invention is shown in the drawing and explained in further detail in the ensuing description. Fig. 1 shows a gear feed pump in an exploded view; Fig. 2 shows the gear feed pump in a longitudinal section taken along the line II-II in Fig. 3; and Fig. 3 shows the gear feed pump in a cross section taken along the line III-III in Fig. 2.

[0009] Description of the Exemplary Embodiment

[0010] An apparatus in the form of a gear feed pump, shown in Figs. 1 through 3, is disposed for instance in a feed line, not shown, from a supply tank to a high-pressure fuel pump or a fuel injection pump of a fuel injection system of an internal combustion engine, for instance for a motor vehicle. The engine is a self-igniting engine, and the fuel that is pumped by the gear feed pump is Diesel fuel. The gear feed pump has a multi-part housing, which has a housing part 10 and a cap part 12. Between the housing part 10 and the cap part 12, a pump chamber 14 is formed, in which a pair of gear wheels 16, 18 is disposed that mesh with one another on their outer circumference. To form the pump chamber 14, the housing part 10 has two indentations 20, 22, from the bottom of each of which a respective bearing journal 24, 26 projects. The bearing journals 24, 26 are embodied integrally with the housing part 10 and extend at least approximately parallel to one another. To reduce the weight of the housing part 10, the bearing journals 24, 26 can be embodied as at least partly hollow. The gear wheel 16 has a bore 17, by way of which it is rotatably supported on the bearing journal 24. The gear wheel 18 has a bore 19, by way of which it is rotatably supported on the bearing journal 26. The bearing journals 24, 26 each determine a respective pivot axis 25, 27 for the gear wheels 16, 18. In the direction of the axes of rotation 25, 27 of the gear wheels 16, 18, the pump chamber 14 is defined on one end by walls 21, 23 of the indentations 20, 22 in the housing part 10 and on the other by a wall 13 of the cap part 12. The cap part 12 is joined

firmly to the housing part 10, for instance by means of a plurality of screws. The housing part 10 and the cap part 12 comprise lightweight metal, preferably aluminum or an aluminum alloy. The gear wheels 16, 18 are preferably of steel, for instance sintered steel.

[0011] The gear feed pump has a drive shaft 30, which is rotatably supported in the housing part 10. The drive shaft 30 is disposed at least approximately coaxially to the bearing journal 24; the housing part 10 has a bore which continues in the bearing journal 24 and through which the end of the drive shaft 30 passes. Between the bore and the drive shaft 30, a shaft sealing ring is built in, for sealing off the housing part 10. The drive shaft 30 is coupled to the gear wheel 16, for instance via a coupling member 36 disposed between the face end of the bearing journal 24 and the cap part 12. In operation of the gear feed pump, the gear wheel 16 is driven to rotate via the drive shaft 30 and transmits this rotary motion via an end tooth to the gear wheel 18, likewise provided with an end tooth, that meshes on its outer circumference with the gear wheel 16. The gear wheels 16, 18 by the meshing of their teeth divide the pump chamber 14 into two portions, of which a first portion forms a suction chamber 40 and a second portion forms a compression chamber 42. The suction chamber 40 communicates with the compression chamber 42 via one pumping conduit 44 each, formed between the grooves between teeth on the circumferential surfaces of the gear wheels 16, 18 and the upper and lower circumferential walls of the pump chamber 14. The suction chamber 40 and the compression chamber 42 each have one connection opening, in the wall of the housing part 10 or of the cap part 12, by way of which the suction chamber 40 communicates with a suction line, not shown, from the supply tank and the compression chamber 42 communicates, via a feed line also not shown, with the suction chamber of the high-pressure fuel pump or the fuel injection pump. The connection opening in the suction chamber 40 forms an inlet opening 46, and the connection opening in the compression chamber 42 forms an outlet opening 48.

[0012] The bearing journals 24, 26 of the housing part 10 form a radial bearing for the gear wheels 16, 18, and to increase the wear resistance of the bearing of the gear wheels 16, 18, they are provided with a coating 50, which comprises a nickel alloy. In particular, the coating 50 comprises a nickel-phosphorus alloy. The nickel-phosphorus alloy contains at least 94% and preferably approximately 95% nickel and a maximum of 6%, preferably approximately 5%, phosphorus. The walls 21, 23 of the housing part 10 and the wall 13 of the cap part 12 form axial bearing points for the gear wheels 16, 18. Alternatively or in addition to the bearing journals 24, 26, the walls 21, 23 of the housing part 10 and the wall 13 of the cap part 12 are provided with the coating 50, to increase the wear resistance of the bearing. The coating 50 has an at least substantially plane microstructure on its surface. As a result, an especially high wear resistance of the coating 50 is attained, even if lubrication is done only by the pumped fuel and if there is mixed friction, that is, sliding friction between the gear wheels 16, 18 and the coating 50. The surface of the coating 50 thus differs substantially from the surface of known coatings that comprise a nickel alloy with an uneven microstructure, or so-called cauliflower structure with budlike, irregularly distributed, ball-like protuberances. Unlike such a structure, the coating 50, because of its plane microstructure, has a uniform distribution of layer thicknesses and has no or only a few flaws on its surface. The replicability of a microhardness measurement of the coating 50 is improved as a result, since the microhardness measurement can be performed at arbitrary points of the coating and furnishes correct results. The coating 50 has a uniform shiny surface color without a detectable addition of heavy metal. Because of the absence of added heavy metal, the gear feed pump can be recycled in accordance with existing regulations.

[0013] The housing part 10 and the cap part 12 are pretreated in a special way before the coating 50 is applied, and the coating 50 is applied by a chemical coating process to the aforementioned regions of the housing part 10 and the cap part 12. The pretreatment and the application of the coating 50 will now be described in further detail. First the housing part 10 and the cap part 12 are cleaned or preheated, which is done in an acid bath, such as a Premal

bath, at room temperature for a period of approximately 20 to 60 seconds, for activating the surface. Next, the parts 10, 12 are rinsed with super-pure water in one or more rinsing operations. The parts are then placed in a persulfate solution at room temperature for a period of approximately 45 to 90 seconds, in which solution the surface of the parts is at least partly oxidized, so that aluminum oxide forms. This is followed by at least one rinsing operation with super-pure water. Next, the parts are placed in a zincate solution at 20° to 28°C for a period of approximately 20 to 60 seconds. In the zincate solution, zinc is present in ionic form, from which elemental zinc precipitates out onto the surface of the parts. This is followed by at least one rinsing operation with super-pure water. Next, the parts are placed as indicated above in a persulfate solution at room temperature for a period of approximately 45 to 90 seconds, and in this solution the surface of the parts is at least partly oxidized. This is followed once again by at least one rinsing operation with super-pure water. Next, the parts are placed once again in a zincate solution at 20° to 28°C for a period of approximately 20 to 60 seconds, so that elemental zinc precipitates out onto the surface of the parts. This is followed by at least one rinsing operation with super-pure water again. The zinc that deposits on the surface of the parts forms a bonding layer for the nickel-phosphorus alloy applied afterward. The parts are now placed in a solution, in which nickel in ionic form and phosphonate are contained, at 28° to 36°C for a period of approximately 3 to 10 minutes; from this solution, the nickel-phosphorus alloy precipitates out onto the surface of the parts. Next, at least one rinsing operation with super-pure water takes place. After that, the parts are placed in a solution in which nickel in ionic form and phosphonate are contained, from which the nickel-phosphorus alloy is deposited onto the surface of the parts, at approximately 80° to 90°C, for a period of time until the required layer thickness is attained. This is followed by at least one rinsing operation with super-pure water. Afterward, drying of the parts takes place, in a first stage at a temperature of approximately 55° to 65°C for a period of approximately 1.5 to 3 minutes, by pulse blowing and in a second stage at a temperature of approximately 55° to 65°C for a period of approximately 6 to 15 minutes by means of hot air. Finally,

heating of the parts is also done, to a temperature of approximately 200° to 220°C for a period of approximately 1 to 2 hours, as a result of which the hardness of the coating 50 is increased.